Scientific Studies of Reading, 19:224–242, 2015

ISSN: 1088-8438 print/1532-799X online
DOI: 10.1080/10888438.2015.1007375

Routledge
Taylor & Francis Group

Text (Oral) Reading Fluency as a Construct in Reading Development: An Investigation of Its Mediating Role for Children From Grades 1 to 4

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In the present study we investigated a developmentally changing role of text reading fluency in mediating the relations of word reading fluency and listening comprehension to reading comprehension. We addressed this question by using longitudinal data from Grades 1 to 4 and employing structural equation models. Results showed that the role of text reading fluency changes over time as children's reading proficiency develops. In the beginning phase of reading development (Grade 1), text reading fluency was not independently related to reading comprehension over and above word reading fluency and listening comprehension. In Grades 2 to 4, however, text reading fluency completely mediated the relation between word reading fluency and reading comprehension, whereas it partially mediated the relation between listening comprehension and reading comprehension. These results suggest that text reading fluency is a dissociable construct that plays a developmentally changing role in reading acquisition.

Reading comprehension is a critical, necessary skill for success in schools and civic life. Theories and empirical studies have shown that reading comprehension is a complex skill drawing from multiple component skills (Cain, Oakhill, & Bryant, 2004; Kendeou & van den Broek, 2007; Kim, in press; Snow, 2002; van den Broek, Fletcher, & Risden, 1993). Of these multiple skills, language comprehension and word reading skills are necessary foundations for reading comprehension (i.e., simple view of reading, see Catts, Adlof, Hogan, & Weismer, 2005; Hoover & Gough, 1990; Johnston & Kirby, 2006; Joshi, Tao, Aaron, & Quiroz, 2012; Mancilla-Martinez, Kieffer, Biancarosa, Christodoulou, & Snow, 2011). Recent evidence, however, suggests that "text" reading fluency, fast and accurate reading of connected text, might be another critical component skill for reading comprehension over and above children's word reading (Jenkins, Fuchs, van den Broek, Espin, & Deno, 2003) and listening comprehension (Kim, Park, & Wagner, 2014; Kim, Wagner, & Lopez, 2012; Tilstra, McMaster, van den Broek, & Rapp, 2009).

According to the two-process expectancy theory (Posner & Snyder, 1975) and the interactive-compensatory model (Stanovich, 1980), inefficient word reading causes children to rely on both conscious and automatic activation processes for word identification. Efficient word reading, in contrast, enables readers to rely less on conscious processes (e.g., attention) for word

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identification. Thus, fast and accurate reading of connected text (text reading fluency) releases readers' limited cognitive resources such as attention and working memory to be used for higher order comprehension processes, facilitating reading comprehension (LaBerge & Samuels, 1974; Samuels, 2006). A number of studies have shown that text reading fluency is strongly related to reading comprehension with bivariate correlations ranging from .67 to .91 for children in primary grades (e.g., Kim, Petscher, Schatschneider, & Foorman, 2010; National Institute of Child Health and Human Development [NICHD], 2000; Silverman et al., 2013) and somewhat weaker relations for children in upper elementary and secondary schools (e.g., Tilstra et al., 2009; Yovanoff, Duesbery, Alonzo, & Tindal, 2005). Given these relations, perhaps it is not surprising that text reading fluency is widely used in North America as a screening and progress monitoring tool for children in primary grades as a proxy for reading comprehension (Jenkins, Hudson, & Johnson, 2007).

Despite its widespread use, however, our understanding is limited about the nature of developmental relations between text reading fluency and reading comprehension. Therefore, the primary goal of the present study is to address this gap in our understanding. Note that in the present study we use the term "text" reading fluency to refer to reading accuracy and rate in "connected texts" or in context, and distinguish it from "word" reading fluency, which is accurate and fast reading of words in isolation or out of context (Jenkins et al., 2003). Although we acknowledge that reading prosody, oral expression during connected text reading, is an important aspect of the definition of reading fluency (e.g., Hudson, Pullen, Lane, & Torgesen, 2009; Kuhn, Schwanenflugel, & Meisinger, 2010; Kuhn & Stahl, 2003), it is beyond the scope of the present study.

Text reading fluency has been characterized as "a bridge" between word reading and reading comprehension (Hudson et al., 2009; Kuhn et al., 2010; Pikulski & Chard, 2005). In other words, text reading fluency plays a mediating role between word reading and reading comprehension. However, at least two points need further clarification about the hypothesized mediation of text reading fluency. First, this hypothesis assumes that text reading fluency is an extension and consequence of only word reading (Pikulski & Chard, 2005; see NICHD, 2000, for a similar view). However, theoretically, the reason why text reading fluency is dissociable from context-free word reading fluency is because automaticity in word reading allows children to focus on meaning construction (Jenkins et al., 2003; Samuels, 2006; Wolf & Katzir-Cohen, 2001), which is in large part a function of their oral language comprehension. Then, text reading fluency not only is an outcome of word reading but also depends upon children's language comprehension (Kim et al., 2014; Kim et al., 2012). In other words, according to the text reading fluency theories, text reading fluency should mediate the relation not only between word reading and reading comprehension but also between listening comprehension and reading comprehension at least to some extent. Recent emerging evidence from English-speaking children (Kim, Wagner, & Foster, 2011; Kim et al., 2012) and Korean-speaking children (Kim et al., 2014) indicates that text reading fluency is uniquely predicted by listening comprehension as well as word reading fluency after children have reached a certain level of word reading proficiency.

The second clarification about the mediating role of text reading fluency involves whether the mediation is static or developmental. Although previous studies have been informative, they were limited in examining developmental relations because many were cross-sectional (Jenkins et al., 2003; Kim et al., 2011; Schwanenflugel et al., 2006; Silverman et al., 2013; Tilstra et al., 2009). Furthermore, in some studies reading fluency was operationalized more broadly than text reading fluency and did not differentiate text reading fluency from word reading fluency. For

instance, Silverman et al. (2013) found reading fluency to be independently related to reading comprehension for children in Grade 4, but their reading fluency construct was composed of sublexical (rapid automatized naming), lexical (word reading fluency), and text-level (text reading fluency) tasks. In the present study, our primary goal was to examine “text” reading fluency as differentiated from “word” reading fluency, and the relations of word reading fluency and text reading fluency to reading comprehension as children develop reading skills. Differentiating text versus word reading fluency allows us to enhance our theoretical understanding about what text reading fluency is, including its mediating role.

A developmental perspective of text reading fluency hypothesizes the changing nature of text reading fluency as a function of children’s reading proficiency (Wolf & Katzir-Cohen, 2001). During the beginning phase, children’s primary focus is decoding, and children’s word reading fluency and text reading fluency are very highly related. Therefore, the influence of word reading fluency and text reading fluency on reading comprehension overlaps to a large extent such that text reading fluency does not mediate relations between word reading fluency and reading comprehension. However, as children develop their word reading proficiency, and listening comprehension can contribute to text reading fluency, and text reading fluency might begin to mediate relations of word reading fluency and listening comprehension to reading comprehension. In a recent study, text reading fluency was not independently related to reading comprehension for English-speaking children in first grade, but it was in second grade, along with word reading fluency and listening comprehension (Kim et al., 2012). What remains unclear is the developmentally changing nature of relations for a longer developmental span. Therefore, in the present study, we sought to expand our understanding about the developmental nature of relations among word reading fluency, listening comprehension, text reading fluency, and reading comprehension, using longitudinal data from English-speaking children in Grades 1 to 4. The primary research question was whether text reading fluency mediates the relation of word reading fluency and listening comprehension to reading comprehension, and if so, how the mediating role changes over time.

METHOD

Participants

The sample students were 316 English-speaking children who participated in a 4-year longitudinal study from Grade 1 to Grade 4 in Florida. Data in Grades 1 and 2 have been reported in previous studies (Kim et al., 2011; Kim et al., 2012), and the present study extends analysis from Grades 1 to 4. Students’ ages were 85 ($SD = 5.67$), 95.92 ($SD = 5.26$), 107.85 ($SD = 5.42$), and 119.97 ($SD = 5.07$) months in Grades 1, 2, 3, and 4, respectively. Of 316 (49% female) students, 270 (49% female) remained in Grade 2, 260 (51% female) in Grade 3, and 219 (52% female) in Grade 4. Most of the observed attrition resulted from several teachers not allowing their students to participate in the longitudinal study. Racial and ethnic backgrounds were as follows in the order of Caucasian, African American, Hispanic, Asian, and Others: 60%, 25%, 4%, 4%, and 7% in Grade 1; 62%, 21%, 5%, 4%, and 7% in Grade 2; 61%, 23%, 5%, 4%, and 7% in Grade 3; 65%, 19%, 6%, 5%, and 5% in Grade 4.

Multivariate analysis of variance results showed that children who remained in the study through Grade 4 did not differ from those who left the study in all the measures in Grade 1 except in mean standard scores of Woodcock Reading Mastery Test–Revised (WRMT-R) and Woodcock–Johnson III (WJ-III) Passage Comprehension measures (ps $< .001$; Wilks's $\Lambda = 1.70$), $F(296, 15) = 1.70$, $p = .05$. The following were mean standard scores of children who stayed in the study and left the study, respectively: $M = 109.97$ ($SD = 10.01$) and $M = 105.31$ ($SD = 10.78$) in the WRMT-R Passage Comprehension; $M = 106.20$ ($SD = 12.76$) and $M = 100.30$ ($SD = 13.04$) in the WJ-III Passage Comprehension. These suggest that children who left the study had lower standard scores in the Passage Comprehension in Grade 1 than those who stayed in the study. In the present study, we utilized all available data for analysis in each grade (i.e., $N = 316$ in Grade 1, 270 in Grade 2, 260 in Grade 3, and 219 in Grade 4), and the Mplus software that was used in the study can handle missing data. When we conducted analysis using only data from children who stayed in the study (stayers, $N = 219$), the pattern of the results (the appendix) was essentially identical as that using all available data in each grade (Figure 1). However, the path coefficients of text reading fluency to reading comprehension tended to be slightly larger in Grades 2, 3, and 4 (βs = .47, .49, and .42, respectively) when using data from stayers. We acknowledge that the attrition is a limitation of the study, and therefore findings should be taken with this caution in mind (see next for further discussion).

Measures

Multiple measures were used to assess the following constructs: listening comprehension, word reading fluency, text reading fluency, and reading comprehension.

Listening comprehension. Three tasks were used: the WJ-III Oral Comprehension subtest (Woodcock, McGrew, & Mather, 2001) and an experimental task. Oral Comprehension is a cloze task in which children complete orally presented sentences (e.g., People sit in ____) and short passages. Cronbach's alpha estimates ranged from .70 to .71. The Oral Comprehension subtest has been shown to be related to other language skills such as Verbal Comprehension ($r = .59$) and Story Recall ($r = .47$) for children 6 to 8 years old (Woodcock et al., 2001). To assess the child's oral language comprehension skills of extended passages such as stories, an experimental measure was developed and used. In the experimental tasks, children listened to two short passages (one narrative and one expository text) read aloud by the assessor and answered four open-ended questions for each passage (a total of eight questions in two passages). The passages were composed of 133 to 230 words. The comprehension questions involved children's recall of details (e.g., What did Pierre take to the town square?) and inference skills (e.g., Do you think Pierre ever got a job? Why?). Children's answers were scored dichotomously (1 = correct; 0 = incorrect) for each question. For the questions that had two parts (e.g., Do you think Pierre ever got a job? Why?), the child had to provide correct answer to both parts. The same passages were used in Grades 1 and 2, whereas passages in Grades 3 and 4 were different. The reliability estimates (alpha) across eight items were .50, .60, .37, and .58 in Grades 1, 2, 3, and 4, respectively. Although these reliability estimates are not ideal, it should be noted that in the latent variable approach, the challenge of somewhat low reliability is ameliorated given that only common variance among measures is used to estimate relations.

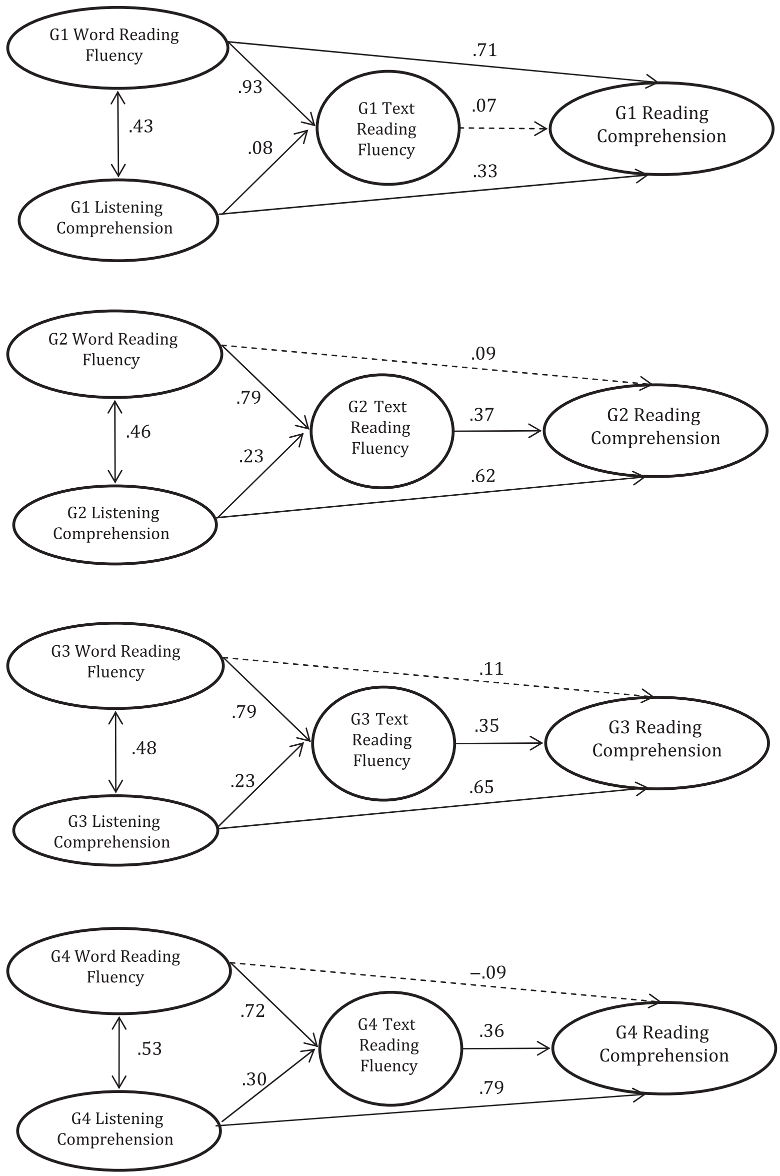

FIGURE 1 Standardized structural regression weights among listening comprehension, word reading fluency, text reading fluency, and reading comprehension. *Note.* Solid lines represent statistically significant relations, and dotted lines statistically nonsignificant relations. To reduce the complexity of the illustrations, *correlations among word reading fluency and listening comprehension at different time points are not shown in the figure although they were modelled.*

Word reading fluency. Two forms (Forms A and B) of the Sight Word Efficiency subtest of the Test of Word Reading Efficiency—Second Edition (TOWRE-2; Torgesen, Wagner, & Rashotte, 2012) were used. In these tasks, the child is asked to read aloud as many words as possible within 45 s. Words increase in difficulty progressively (e.g., from simple single-syllable to multisyllabic words). Total score is the number of correctly read words within 45 s. Test–retest reliabilities have been reported to range from .96 to .97 (Torgesen et al., 2012). The Sight Word Efficiency task has been shown to be highly related to other reading measures of Gray Oral Reading Test–4 reading fluency ($r = .91$), Test of Silent Contextual Reading Fluency ($r = .75$), and WRMT-R Passage Comprehension ($r = .88$; Torgesen et al., 2012).

Text Reading Fluency. A widely used "oral" text reading fluency task were employed, using three grade-level midyear passages from the Dynamic Indicators of Basic Early Literacy Skills (DIBELS) Text Reading Fluency (6th ed.; Good, Kaminski, & Dill, 2007). In these tasks, the child was asked to read the passages aloud for 1 min, and the number of words accurately read during the interval was calculated. Word omissions, substitutions, and hesitations of more than 3 s were scored as errors. Reliabilities have been reported to range from .92 to .97 (Shaw & Shaw, 2002). DIBELS text reading fluency has been shown to be highly related to other reading fluency tasks such as Gray Oral Reading Test–4 ($.86 \leq rs \leq .88$; Hudson, Torgesen, Lane, & Turner, 2012) and to reading comprehension (Good, Simmons, & Kame'enui, 2001; Riedel, 2007; Roehrig, Petscher, Nettles, Hudson, & Torgesen, 2008).

Reading Comprehension. Reading comprehension was measured by the WJ-III Passage Comprehension subtest (Woodcock et al., 2001), WRMT-R Passage Comprehension subtest (Woodcock, 1987), and an experimental task. Both Woodcock measures are cloze tasks in which the child is asked to read sentences and passages and fill in a correct word based on the texts read. Although the Woodcock tasks have the same format, the items are different in these tasks and are normed on different samples. Cronbach's alpha estimates for WJ-III and WRMT-R Passage Comprehension tasks ranged from .84 to .93 across grades. Studies have shown that reading comprehension tasks vary in the extent to which they tap into component skills. For instance, cloze tasks such as WJ-III and WRMT-R Passage Comprehension tasks have been shown to tap into word reading to a greater extent than to oral language compared to other reading comprehension tasks (e.g., reading passages and answering questions; Cutting & Scarborough, 2006; Keenan, Betjemann, & Olson, 2008). Therefore, an experimental task was developed and used. In this task, children were asked to read two short passages (one narrative and one expository) and answer four open-ended questions in each passage that required children to recall details in the passage (e.g., Where does Harry live?) and make inferences (e.g., Why did Harry and Sally both see windows made of gold, but at different times of the day?). The passages ranged from 126 to 218 words with a total of eight questions per grade. Children's answers were scored dichotomously (1 = correct; 0 = incorrect) for each question. Cronbach's alpha estimates across eight items were .61, .62, .58, and .43 in Grades 1, 2, 3, and 4, respectively. Note that reliability estimates of experimental measures appear to decrease particularly in Grade 4. However, again, given the use of a latent variable approach, only common variance among standardized and experimental measures are used in estimating relations, and thus reducing the impact of lower reliability in Grade 4.

Procedures

All the assessments were individually administered in quiet areas by trained research assistants. Children were assessed in two 30-min sessions. The assessments were administered at the end of the fall semester and during the spring semester. To minimize time-sampling error, multiple measures of each construct were administered during different testing sessions to the extent possible. In all grades, assessments were administered in the following order: text reading fluency, WJ-III Passage Comprehension, WJ-III Oral Comprehension, researcher-developed reading comprehension, TOWRE Sight Word Efficiency, researcher-developed listening comprehension, and WRMT Passage Comprehension.

Data Analysis

Confirmatory factor analysis and structural equation modeling were employed as the primary analytic strategies using MPLUS 7.0 (Muthén & Muthén, 2013). Preliminary analyses confirmed that univariate and multivariate normality assumptions were met overall despite some floor effects in Grade 1 (see next), and all the measurement models were appropriate. Model fits were evaluated by the following multiple indices: chi-square statistics, comparative fit index (CFI), the Tucker-Lewis index (TLI), root mean square error of approximation (RMSEA), and standardized root mean square residuals (SRMR). RMSEA values below .08, CFI and TLI values equal to or greater than .95, and SRMR equal to or less than .05 indicate an excellent model fit (Hu & Bentler, 1999). TLI and CFI values greater than .90 are considered to be acceptable (Kline, 2005).

Because the analysis involved a longitudinal sample, measurement invariance was examined following procedures described in Brown (2006) and Thompson and Green (2006).

Establishing measurement invariance is important because the indicators that measure the constructs in one time point should be the same as another time point (i.e., factor loadings from observed measures to hypothesized latent variables across time points) to ensure unbiased effects of the measures across time points (Byrne & Watkins, 2003).

RESULTS

Descriptive Statistics and Preliminary Analyses

Table 1 presents descriptive statistics (i.e., means, standard deviations, minimum, and maximum) of measures in Grades 1 to 4. The participating children's mean performances in the language and reading measures were in the average range compared to the norms (e.g., WJ-III Oral Comprehension, TOWRE Sight Word Efficiency, and Woodcock Passage Comprehension measures). Although not relevant to addressing the research questions, we also report children's performances on word reading accuracy, measured by the WJ-III Letter Word Identification Task for descriptive purposes. In this task, the child is asked to read aloud increasingly difficult words. Children's mean standard scores on the Letter Word Identification Task tended to be high average ranging from 112.54 in Grade 1 to 107.99 in Grade 4. This compares to average performances

TABLE 1
Descriptive Statistics

	First Grade		*Second Grade*		*Third Grade*		*Fourth Grade*	
	M (SD)	*Min–Max*	*M (SD)*	*Min–Max*	*M (SD)*	*Min–Max*	*M (SD)*	*Min–Max*
Listening comprehension								
WJ Oral Comprehension	14.10 (3.31)	5–23	17.13 (3.44)	5–25	19.36 (3.85)	9–28	21.35 (3.86)	8–28
WJ Oral Comprehension (SS)	107.09 (11.07)	82–137	108.89 (11.42)	76–136	108.68 (12.33)	78–136	109.50 (12.05)	71–130
Experimental task	2.50 (1.53)	0–7	3.68 (1.80)	0–8	5.39 (1.43)	1–8	3.93 (1.80)	0–8
Word reading accuracy[a]								
WJ Letter Word Identification	35.78 (7.85)	17–57	45.69 (6.78)	26–66	51.55 (6.80)	35–69	55.19 (6.22)	33–70
WJ Letter Word Identification (SS)	112.54 (13.44)	70–143	109.62 (10.63)	72–136	107.55 (10.65)	76–136	107.99 (10.51)	72–136
Word reading fluency								
SWE Form 1	34.98 (16.56)	3–70	57.73 (11.29)	12–81	64.20 (10.81)	26–88	69.23 (9.65)	34–92
SWE Form 1 (SS)	99.72 (17.19)	55–144	109.52 (14.00)	11–138	100.70 (14.32)	56–138	101.04 (13.00)	61–133
SWE Form 2	34.94 (16.65)	3–70	56.32 (12.08)	12–83	64.82 (10.68)	38–84	68.72 (10.02)	34–97
SWE Form 2 (SS)	99.46 (17.50)	36–142	108.43 (14.21)	12–137	101.43 (14.04)	58–133	100.48 (13.48)	61–138
Text reading fluency								
ORF Passage 1	56.53 (37.14)	0–176	108.81 (37.35)	11–207	113.66 (37.07)	22–235	112.29 (35.09)	27–221
ORF Passage 2	52.85 (35.06)	3–142	100.77 (38.03)	9–206	102.79 (38.42)	8–217	118.55 (30.58)	24–205
ORF Passage 3	52.62 (36.06)	2–184	92.72 (30.00)	10–197	118.30 (32.40)	19–242	145.30 (35.58)	32–233
Reading comprehension								
WRMT-R Passage Comp	21.06 (8.52)	1–38	29.95 (6.13)	8–47	35.28 (5.97)	16–51	38.40 (6.01)	16–52
WRMT-R Passage Comp (SS)	108.54 (10.46)	75–132	107.89 (10.64)	77–193	106.06 (9.78)	81–134	105.29 (10.12)	77–130
WJ Passage Comp	18.01 (5.13)	6–31	24.46 (4.65)	12–35	27.96 (4.25)	14–37	29.98 (4.09)	15–55
WJ Passage Comp (SS)	104.38 (13.12)	68–136	103.26 (10.40)	72–125	102.03 (9.83)	72–127	101.72 (9.34)	68–126
Experimental task	3.26 (1.82)	0–8	5.05 (1.80)	1–8	4.72 (1.88)	0–8	3.49 (1.58)	0–7

Note. WJ = Woodcock Johnson Tests of Achievement–Third Edition; SS = standard score; SWE = Sight Word Efficiency subtest of the Test of Word Reading Efficiency; ORF = Oral Reading Fluency; WRMT–R = Woodcock Reading Mastery Test–Revised.

[a]Children's performances on the WJ-III Letter Word Identification is reported for descriptive purposes, and were not relevant and thus not used in the analysis.

on the Sight Word Efficiency tasks with mean standard scores with an exception in Grade 2. Similar trend of higher mean standard scores in the WJ-III Letter Word Identification compared to the Sight Word Efficiency has been reported in previous studies (e.g., Al Otaiba, Kim, Wanzek, Petscher, & Wagner, 2014). Tables 2 (Grades 1 and 2) and 3 (Grades 3 and 4) present bivariate correlations among the observed measures. Relations were all in the expected directions.

Using the observed variables, measurement models were fitted for the following latent variables: listening comprehension, word reading fluency, text reading fluency, and reading comprehension. Measurement models were all appropriate, and standardized loadings and *p* values are presented in Table 4. To examine whether word reading fluency and text reading fluency

TABLE 2
Correlations Among Observed Variables for English-Speaking Children in Grades 1 and 2

	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
1. WJ-III Oral Comprehension	—	.55	.39	.38	.43	.41	.42	.51	.50	.44
2. Ex listening comprehension	.55	—	.22	.23	.27	.27	.26	.35	.39	.37
3. Sight Word Efficiency Form 1	.32	.30	—	.96	.94	.94	.93	.86	.84	.62
4. Sight Word Efficiency Form 2	.33	.20	.92	—	.92	.94	.93	.85	.83	.65
5. DIBELS ORF passage 1	.43	.40	.82	.83	—	.96	.97	.84	.84	.65
6. DIBELS ORF passage 2	.37	.39	.85	.84	.94	—	.96	.83	.83	.64
7. DIBELS ORF passage 3	.41	.38	.84	.85	.92	.92	—	.83	.83	.62
8. WRMT-R Passage comprehension	.56	.50	.61	.59	.69	.65	.66	—	.87	.62
9. WJ-III Passage comprehension	.59	.50	.64	.63	.75	.71	.72	.81	—	.66
10. Ex reading comprehension	.52	.45	.39	.37	.49	.44	.46	.65	.62	—

Note. In the top panel, above diagonal in Grade 1 and below diagonal in Grade 2. In the bottom panel, above diagonal in Grade 3 and below diagonal in Grade 4. All coefficients are statistically significant at .01 level. WJ-III = Woodcock Johnson Tests of Achievement–Third Edition; DIBELS = Dynamic Indicators of Basic Early Literacy Skills; ORF = Oral Reading Fluency; WRMT-R = Woodcock Reading Mastery Test–Revised; Ex = experimental.

TABLE 3
Correlations Among Observed Variables for English-Speaking Children in Grades 3 and 4

	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
1. WJ-III Oral Comprehension	—	.55	.36	.41	.45	.44	.43	.59	.62	.62
2. Ex listening comprehension	.56	—	.19	.26	.31	.30	.27	.46	.45	.38
3. Sight Word Efficiency Form 1	.37	.39	—	.89	.80	.77	.78	.58	.56	.43
4. Sight Word Efficiency Form 2	.38	.42	.90	—	.81	.79	.81	.62	.60	.45
5. DIBELS ORF passage 1	.50	.49	.78	.78	—	.93	.92	.72	.69	.55
6. DIBELS ORF passage 2	.44	.46	.79	.80	.92	—	.93	.72	.70	.53
7. DIBELS ORF passage 3	.46	.48	.80	.80	.90	.92	—	.69	.67	.55
8. WRMT-R Passage comp	.68	.53	.53	.53	.68	.67	.65	—	.79	.62
9. WJ-III Passage comp	.61	.45	.46	.46	.62	.60	.61	.72	—	.59
10. Ex reading comprehension	.50	.39	.31	.34	.48	.47	.42	.50	.49	—

Note. Above diagonal in Grade 3 and below diagonal in Grade 4. All coefficients are statistically significant at .01 level. WJ-III = Woodcock–Johnson Tests of Achievement–Third Edition; ORF = Oral Reading Fluency; WRMT-R = Woodcock Reading Mastery Test–Revised; Ex = experimental.

TABLE 4
Standardized Loadings and Residuals for Children in Grades 1, 2, 3, and 4

	First Grade		*Second Grade*		*Third Grade*		*Fourth Grade*	
	Loading (SE)	*Residuals (SE)*	*Loading (SE)*	*Residuals (SE)*	*Loading (SE)*	*Residuals (SE)*	*Loading (SE)*	*Residuals (SE)*
Listening comprehension								
WJ Oral Comprehension	.78 (.03)	.40 (.05)	.81 (.03)	.34 (.05)	.88 (.03)	.23 (.05)	.90 (.03)	.20 (.05)
Ex listening comprehension	.71 (.03)	.50 (.05)	.68 (.04)	.53 (.05)	.63 (.04)	.60 (.05)	.64 (.05)	.59 (.06)
Word reading fluency								
SWE 1	.98 (.003)	.03 (.005)	.97 (.006)	.05 (.01)	.94 (.009)	.13 (.02)	.96 (.008)	.08 (.02)
SWE 2	.98 (.003)	.04 (.006)	.95 (.008)	.11 (.02)	.96 (.008)	.09 (.02)	.94 (.009)	.11 (.02)
Text reading fluency								
ORF Passage 1	.99 (.002)	.03 (.004)	.96 (.006)	.08 (.01)	.97 (.005)	.06 (.009)	.95 (.007)	.10 (.01)
ORF Passage 2	.98 (.003)	.04 (.005)	.95 (.008)	.11 (.01)	.95 (.007)	.10 (.01)	.97 (.005)	.05 (.009)
ORF Passage 3	.98 (.002)	.03 (.005)	.96 (.005)	.08 (.01)	.96 (.005)	.08 (.01)	.93 (.009)	.13 (.02)
Reading comprehension								
WRMT-R Passage Comp	.93 (.009)	.13 (.02)	.91 (.01)	.17 (.02)	.90 (.01)	.19 (.02)	.89 (.02)	.33 (.04)
WJ Passage Comp	.93 (.009)	.13 (.02)	.88 (.02)	.22 (.03)	.87 (.02)	.24 (.03)	.82 (.03)	.22 (.03)
Ex reading comprehension	.69 (.03)	.52 (.04)	.71 (.03)	.50 (.05)	.70 (.03)	.51 (.05)	.63 (.04)	.61 (.05)

Note. WJ = Woodcock–Johnson III; Ex = experimental; SWE = Sight Word Efficiency; ORF = text reading fluency; WRMT-R = Woodcock Reading Mastery Test–Revised.

are best described as a single construct or are related but dissociable constructs, confirmatory factor analyses were conducted. Across grades, the models with word reading fluency and text reading fluency as separate latent variables had statistically significantly better fit according to chi-square difference tests (*p*s $< .01$). To examine measurement invariance, a baseline model of noninvariance was first specified in which the loadings were allowed to vary completely. This model demonstrated a good fit to the data, $\chi^2(620) = 860.90$, $p < .001$ (CFI = .98, TLI = .98, RMSEA = .035, SRMR = .035). When a full invariance model was fitted, it had a statistically poorer fit, $\chi^2(640) = 1973.09$, $p < .001$ (CFI = .91, TLI = .89, RMSEA = .081, SRMR = .178), $\chi^2(df = 20) = 1112.19$, $p < .001$. Thus, we fitted partial invariance models in subsequent analysis by examining the loadings of each observed variable on its corresponding latent variable, and relaxing equal loading constraints for the following variables: The researcher developed listening comprehension measures in all 4 years, and the researcher developed reading comprehension measures in all 4 years. Although full measurement invariance is desirable, partial measurement invariance is most common because of subtle changes in measurement properties of indicators (e.g., reliability estimates) when given across multiple years.

Correlations among latent variables are presented in Table 5. Overall, the relation between listening comprehension and reading comprehension became stronger from the beginning to the more advanced stage in reading, with correlation coefficients increasing from .65 to .89 in Grades 1 to 4. In contrast, the relations between both word reading fluency and text reading fluency and reading comprehension decreased as children advanced in their reading skills from .93 in Grade 1 to .62 in Grade 4. Finally, word reading fluency remained strongly related to text reading fluency across developmental phases ($.87 \leq rs \leq .96$).

Developmental Relations Among Listening Comprehension, Word Reading Fluency, Text Reading Fluency, and Reading Comprehension

Structural equation modeling was conducted to examine the relations of word reading, listening comprehension, text reading fluency, and reading comprehension from Grades 1 to 4. Word

TABLE 5
Correlations Between Latent Variables

		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
1	G1 Listening comp	1														
2	G1 Word RF	0.43	1													
3	G1 Text RF	0.48	0.97	1												
4	G1 Reading comp	0.65	0.93	0.91	1											
5	G2 Listening comp	0.99	0.44	0.47	0.65	1										
6	G2 Word RF	0.35	0.78	0.74	0.72	0.44	1									
7	G2 Text RF	0.47	0.81	0.82	0.78	0.56	0.91	1								
8	G2 Reading comp	0.76	0.75	0.75	0.9	0.81	0.71	0.8	1							
9	G3 Listening comp	0.92	0.46	0.45	0.64	0.91	0.38	0.49	0.74	1						
10	G3 Word RF	0.37	0.68	0.66	0.64	0.47	0.88	0.66	0.66	0.46	1					
11	G3 Text RF	0.48	0.73	0.78	0.75	0.56	0.84	0.93	0.79	0.51	0.87	1				
12	G3 Reading comp	0.75	0.73	0.73	0.87	0.79	0.69	0.76	0.98	0.79	0.72	0.83	1			
13	G4 Listening comp	0.88	0.48	0.5	0.66	0.94	0.45	0.56	0.76	0.89	0.47	0.55	0.75	1		
14	G4 Word RF	0.37	0.64	0.62	0.58	0.50	0.85	0.62	0.63	0.41	0.89	0.83	0.64	0.49	1	
15	G4 Text RF	0.51	0.73	0.74	0.75	0.59	0.84	0.92	0.78	0.54	0.87	0.95	0.80	0.59	0.88	1
16	G4 Reading comp	0.84	0.62	0.64	0.8	0.87	0.65	0.72	0.95	0.82	0.66	0.76	0.99	0.89	0.62	0.79

Note. All coefficients are statistically significant at .001 level. G = grade; RF = reading fluency.

reading fluency and listening comprehension were hypothesized to have direct paths to text reading fluency. In addition, text reading fluency was hypothesized to have a direct path to reading comprehension, mediating the relations between word reading fluency and listening comprehension, and reading comprehension. As previously noted, partial invariance model was employed, and the model fit was good: $\chi^2(700) = 1291.56$, $p < .001$ (CFI = .96, TLI = .96, RMSEA = .05, SRMR = .055). The results are shown in Figure 1. Note that although all the predictors were allowed to covary across years as well, in order to reduce the complexity of the figure, those correlations are not presented in the figure. Correlation coefficients are as follows across years: $.66 \leq r\text{s} \leq .93$ for word reading fluency, $.92 \leq r\text{s} \leq .96$ for listening comprehension, and $.34 \leq r\text{s} \leq .81$ for text reading fluency. Correlations among reading comprehension across years were constrained to be 1 because they were high ranging from .87 to .99 in bivariate correlations (Table 5).

As shown in Figure 1, word reading fluency was strongly related to text reading fluency in Grades 1, 2, 3, and 4, with modest decline in magnitudes as children developed their reading skills ($\gamma = .93$ in Grade 1 to $\gamma = .72$ in Grade 4, $p\text{s} < .001$). Listening comprehension was uniquely but weakly related to text reading fluency in Grade 1 ($\gamma = .08$, $p = .001$), and became more strongly related was in Grades 2, 3, and 4 ($\gamma s = .23$, .23, and .30, respectively, $p\text{s} < .001$). When it comes to the mediational role of text reading fluency, in Grade 1, word reading fluency ($\gamma = .71$, $p < .001$) and listening comprehension ($\gamma = .33$, $p < .001$) were uniquely related to reading comprehension, whereas text reading fluency was not ($\beta = .07$, $p = .44$). In Grade 2, listening comprehension was fairly strongly related to reading comprehension ($\gamma = .62$, $p < .001$), whereas word reading fluency was not ($\gamma = .09$, $p = .32$). Text reading fluency was somewhat moderately related to reading comprehension ($\gamma = .37$, $p < .001$) over and above word reading fluency and listening comprehension. In Grades 3 and 4, the pattern of relations was similar to Grade 2 such that text reading fluency was somewhat moderately related to reading comprehension ($\beta\text{s} = .35$ and .36, $p\text{s} < .001$), and listening comprehension was fairly strongly and strongly related to reading comprehension ($\gamma\text{s} = .65$ and .79, $p\text{s} < .001$).

DISCUSSION

The primary goal of the present study was to investigate the developmental nature of a mediating relation of text reading fluency to reading comprehension. Overall findings support the hypothesis of text reading fluency being “a bridge” to reading comprehension—playing a mediating role in the relation between word reading and listening comprehension, and reading comprehension. However, the results highlight developmental nature of the relations.

Component skills of reading comprehension (word reading fluency, text reading fluency, and listening comprehension) and their relations to reading comprehension changed over time. In Grade 1, reading comprehension was largely explained by word reading fluency, and moderately by listening comprehension but not by text reading fluency. In Grade 2, listening comprehension became more strongly related to reading comprehension and text reading fluency became independently related to reading comprehension. In fact, this pattern of relations remained in Grades 3 and 4 although listening comprehension became more strongly related to reading comprehension in Grade 4. The increasing role of listening comprehension is convergent with the theoretical hypothesis that word reading has a strong influence on reading comprehension

during the beginning phase of reading development, whereas the influence of listening comprehension becomes stronger over time (Francis et al., 2005; Hoover & Gough, 1990). Previous studies showed a similar pattern of increasing influence of listening comprehension on reading comprehension with English-speaking children (Adlof, Catts, & Little, 2006; Joshi et al., 2012) as well as Korean-speaking children (Kim et al., 2014) and Spanish-speaking children (Joshi et al., 2012).

Of importance, the present study showed that text reading fluency is a differentiated construct from word reading fluency and is an additional factor that influences reading comprehension over and above word reading fluency and listening comprehension after children have developed a certain level of word reading proficiency—Grade 2 in the present study. We hypothesized that text reading fluency largely develops from word reading fluency (Ehri, 2002; NICHD, 2000), but it also involves meaning-related processes associated with context, and thus involves children's oral language comprehension. This hypothesis was confirmed such that initially text reading fluency was highly related to word reading fluency ($r = .96$ in Grade 1), but with further reading development, text reading became more influenced by listening comprehension ($\gamma = .08$ in Grade 1 to $\gamma = .30$ in Grade 4) and increasingly dissociated from word reading fluency. This finding is in line with the hypothesis that word reading constrains reading to a large extent in the beginning phase, and as children develop word reading skill, more cognitive resources are available for meaning-related processes (Jenkins et al., 2003; Stanovich, 1980). Coupled with recent studies with English-speaking and Korean-speaking children (Kim et al., 2014; Kim et al., 2011; Kim et al., 2012), the present study provides empirical support that text reading fluency is a separate construct from word reading fluency because it is a function of not only word reading fluency but also listening comprehension. Thus, text reading fluency acts as a bridge not only between word reading fluency and reading comprehension as hypothesized (Pikulski & Chard, 2005), but also between listening comprehension and reading comprehension. Note, however, that the nature of mediation differed for word reading fluency and listening comprehension—text reading fluency completely mediated the relation between word reading fluency and reading comprehension in Grades 2 to 4. In comparison, text reading fluency partially mediated the relation between listening comprehension and reading comprehension across Grades 2 to 4. This indicates that different language and cognitive skills captured in listening comprehension are likely to be involved in text reading fluency versus reading comprehension (see Kim, 2014). Overall, the present findings support the theoretical account of text reading fluency as a component skill of reading comprehension (Fuchs, Fuchs, Hosp, & Jenkins, 2001; Hudson et al., 2012; Kuhn et al., 2010; LaBerge & Samuels, 1974) and the importance of considering developmentally changing nature of relations (Wolf & Katzir-Cohen, 2001). Note, however, that the present findings should be interpreted in the context of how text reading fluency was operationalized—reading accuracy and rate in connected texts. Reading prosody, an important part of the definition of the text reading fluency construct, has been suggested to be implicated in reading comprehension (e.g., Kuhn et al., 2010; Ravid & Mashraki, 2007; Schwanenflugel, Hamilton, Kuhn, Wisenbaker, & Stahl, 2004) but was not included in the present study.

It is worth noting that the relation of text reading fluency to reading comprehension remained stable from Grades 2 to 4, whereas listening comprehension became more strongly related to reading comprehension. These compare interestingly to a recent study with Korean-speaking children, which showed a similar pattern of unique contributions of text reading fluency and listening comprehension for children at a relatively early phase of reading development (i.e.,

kindergarten), but at a more advanced phase in Grade 1, listening comprehension dominated the relation ($\gamma = .90$) and text reading fluency did not make an independent contribution to reading comprehension (Kim et al., 2014). A stronger effect of listening comprehension compared to word reading skill has been hypothesized at an advanced phase of reading development (Hoover & Gough, 1990). However, in English a very strong, dominant relation of listening comprehension to reading comprehension with correlations above .90 were found for readers in eighth grade and college students (Adlof et al., 2006; Gernsbacher, Varner, & Faust, 1990).

One potential explanation for this discrepancy in Korean and English might be differences in orthographic depth as Korean has a relatively transparent orthography, whereas English has a deep orthography. Because word reading acquisition occurs at a faster rate in transparent orthographies—Seymour, Aro, and Erskine's (2003) study showed that word reading accuracy development takes more than twice the time in English than transparent orthographies—the changing nature of relations among word reading fluency, listening comprehension, text reading fluency, and reading comprehension might occur at an expedited rate in a transparent orthography compared to English. This speculation can be examined by modeling the nature of relations among word reading fluency, text reading fluency, listening comprehension, and reading comprehension with English-speaking students beyond Grade 4, and with children learning to read in transparent orthographies (see Kim, under review). This would enhance our understanding about generalizability of the present findings and our understanding about orthography-specific vs orthography-general processes and patterns.

Note that text reading fluency was a dissociable construct from word reading fluency in the present study and previous studies (Kim et al., 2014) is discrepant from Adlof et al.'s (2006) study with children in Grades 2, 4, and 8 and Schwanenflugel et al.'s (2006) study with children in Grades 1 to 3. However, these discrepant findings might be due to the number of measures of text reading fluency versus word reading fluency, as Adlof et al.'s and Schwanenflugel's studies included a single measure of text reading fluency, and thus text reading fluency measures were combined with word reading fluency to represent reading fluency, whereas in the present study we had sufficient number of measures (i.e., three tasks; Kline, 2011) to test whether word reading fluency and text reading fluency are separate constructs.

The present findings offer some practical implications, albeit preliminary due to correlational nature of the present study. First, the finding that text reading fluency is an important skill for reading comprehension in addition to word reading and listening comprehension suggests that instructional attention is warranted to text reading fluency. Previous studies have shown that instruction on text reading fluency (e.g., repeated reading) improved reading comprehension (Vadasy & Sanders, 2008). Furthermore, the finding that listening comprehension was consistently related to text reading fluency indicates that text reading fluency is a function not just of word reading but also of oral language comprehension. Previous studies of text reading fluency focused on word reading skill such as repeated reading to improve text reading fluency (see NICHD, 2000), but the present finding suggests that oral language comprehension skill merits instructional attention not only for reading comprehension but also for text reading fluency.

A few limitations and future directions are worth noting. First, some measures suffered from low reliabilities. Although their impacts on path coefficients are reduced in a latent variable approach, a future study with higher reliability of estimates is needed to replicate the present findings. Furthermore, children who did not stay through the study had lower standard scores in the two standardized reading comprehension measures in Grade 1, which limits generalizability

of the present findings. As previously noted, when analysis was conducted with those who stayed in the study (stayers), the patterns of results were the same as reported in the study. However, the coefficients from text reading fluency to reading comprehension tended to slightly larger for the stayers, compared to when using all the available data in each grade. These results suggest that although the pattern of developmental relations might be similar if "leavers" stayed in the study, the reading ability of the sample might influence the strength of relations, particularly that between text reading fluency to reading comprehension. That is, if leavers stayed in the study, and their reading comprehension was lower than "stayers" in Grades 2, 3, and 4, the relation of text reading fluency to reading comprehension might have been somewhat weaker than what is reported in the present study. We believe that this speculation is partially in line with our developmental hypothesis that the nature of relations change as a function of children's reading skill level. The stronger relation of text reading fluency to reading comprehension with only "stayers" indicates that as children's reading skills advance, an independent relation of text reading fluency to reading comprehension is expected. However, future replications with lower attrition rate and/or studies with samples of different reading skill levels are necessary to examine this speculation.

It is also important to note that the present findings were from children whose reading skills were largely in the average range, although differences in mean standard scores were found across measures—performances on the WJ-III Letter Word Identification were in the high average range whereas those on the Sight Word Efficiency were in the average range. Therefore, the present findings may not generalize to children with lower reading abilities, those with reading disability, and/or English-language learners. For instance, Kim (2012) found that for Spanish-speaking English-language learners, despite their equivalent levels of word reading skills to English native speakers in Kim et al. (2011), their listening comprehension was not independently related to text reading fluency, whereas listening comprehension was uniquely related to text reading fluency for English native speakers. It was speculated that English-language learners' lower level of listening comprehension might have constrained utilizing language comprehension in their text reading.

Another limitation includes selection of tasks for target constructs in the study. For the word reading fluency and text reading fluency constructs, we employed widely used tasks for these constructs such as DIBELS oral text reading fluency tasks, but they had the same task formats. Other text reading fluency measures exist (e.g., GORT), and it appears that curriculum based measures of oral text reading fluency such as those in the present study are highly related to GORT (Hudson et al., 2012). In contrast to word reading fluency and text reading fluency, listening comprehension and reading comprehension were measured by various types of tasks. This is partly due to nature of the constructs of listening comprehension and reading comprehension. That is, there is relatively less consensus about how to best measure reading comprehension than word reading fluency and text reading fluency (oral reading fluency in particular), and studies have shown that reading comprehension tasks vary in the extent to which they measure various component skills (Cutting & Scarborough, 2006; Keenan et al., 2008). Therefore, in the present study we attempted to complement standardized measures with experimental measures. Given that latent variables are a function of indicators, future studies could replicate the present study using a greater variety of measures than those in the study.

In summary, despite limitations just noted, the present findings suggest that text reading fluency is an important, independent construct to consider in reading development, and it makes an independent contribution to reading comprehension over and above word reading fluency and

listening comprehension. Future studies are warranted to deepen our understanding of the nature and role of text reading fluency in reading development.

ACKNOWLEDGMENTS

We thank participating children, teachers, and schools.

FUNDING

The research reported here was supported by Grant P50 HD052120 from the National Institute of Child Health and Human Development awarded to the second author and by Grant R305A120147 from the Institute of Education Sciences, U.S. Department of Education awarded to the first author. The opinions expressed are those of the authors and do not represent views of the funding agencies.

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APPENDIX

Standardized structural regression weights among listening comprehension, word reading fluency, text reading fluency, and reading comprehension using data from children who stayed through the project ($N = 219$). Solid lines represent statistically significant relations, and dotted lines statistically nonsignificant relations. To reduce the complexity of the illustrations, *correlations among word reading fluency and listening comprehension at different time points are not shown in the figure although they were modeled*.